

for each species. This is based on the climate analysis methods described by Busby (1991), but uses a 30-minute grid. This grid should soon be reduced to a 6-minute interval.

## DISCUSSION

The value of the atlas will depend on the quality and extent of the data held within it. A wide spread of records across time and space is needed if we are to understand the needs of, and threats to, various species. The higher the accuracy of the geographic location of the record the more use it will be in modelling species distributions at the local level. However, for rare and poorly known species even imprecise records can be invaluable in furthering our knowledge. Similarly, historical records are very important if we are to determine the

past distribution of each species and hence assess if its range is contracting or not.

All interested people, whether Service staff or not, are encouraged to use the system and to submit their records, including historical records, for inclusion in the system.

## REFERENCES

- BUSBY, J. R., 1991. BIOCLIM — A Bioclimatic Analysis and Prediction System. In *Nature Conservation: Cost Effective Biological Survey and Data Analysis* ed by C. R. Margules and M. P. Austin. CSIRO: Canberra.
- DICKMAN C. R., PRESSEY, R. L., LIM, L. AND PARNABY, H. E., in press. Mammals of particular conservation concern in the Western Division of New South Wales. *Biol. Conserv.*
- GALL, B. C., 1981. *Wildlife Inventory Program Recorder's Handbook*. New South Wales National Parks and Wildlife Service: Sydney.
- GALL, B. C. AND CHRISTIAN, K. R., 1984. A program for a wildlife inventory. *J. Envir. Manage.* **19**: 277–89.

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## A note on the predation of *Bufo marinus* juveniles by the ant *Iridomyrmex purpureus*

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The introduced cane toad *Bufo marinus* produces toxic compounds from dermal glands (Tyler 1987). These compounds restrict the number of potential predators of adult toads in Australia (Covacevich and Archer 1975; Hamley and Georges 1985) because predators either find the toads unpalatable or die following consumption. Similarly, eggs and tadpoles are toxic (Licht 1968; Wassersug 1971) and therefore may have a limited number of predators.

However, newly metamorphosed toads may lack the concentration of toxins of adults (Flier *et al.* 1980; Freeland and Kerin 1991) and Australian native animals have been observed eating, or have been fed, young cane toads with little or no adverse effects (Covacevich and Archer 1975). Newly metamorphosed toads are also small, active during daylight periods and commonly occur in dense aggregations around breeding sites (Freeland and Kerin 1991). This combination of characteristics suggests that newly metamorphosed toads may be the stage most vulnerable to predators (Zug and Zug 1975; Van Beurden 1980).

We report here on predation of newly metamorphosed toads (toadlets) by the common meat ant *Iridomyrmex purpureus* and the diurnal activity patterns of both species over one 24 h period.

*Iridomyrmex purpureus* was observed preying on toadlets at a natural pond 40 km north of Chinchilla in south Queensland on three occasions (February 3, March 8 and March 14–15, 1992). The oval shaped pond had a circumference of 270 m and was surrounded by sparse woodland and a grass understorey. There was little ground cover at the pond edge.

During daylight *I. purpureus* preyed upon toadlets around the margin of the pond. Capture of a single toadlet involved several ants with one ant making initial contact and inhibiting toad movement, followed by three to four more ants each grabbing a limb of the victim. The captured toadlet was spread out by an ant tugging at each leg and other ants would then sever the legs from the torso. All the parts were carried to the ant nest 30 m from the pond edge.

A random sample of 129 toadlets captured on March 15 revealed a size range of 9.7–23.8 mm snout–urostyle length (SUL) ( $\bar{x} = 12.3$ ,  $sd = 2.4$ ). The time taken to deal with a captured toadlet appeared to be size dependent. Small toadlets (approx. 10–15 mm SUL) took between 20 and 30 min. to be processed ( $n = 5$ ) while a single juvenile (approx. 30 mm SUL) was observed being incompletely dissected over a 4 h period.

The toadlets displayed aversion behaviour with the approach of an ant and only a small portion of ant-toad encounters resulted in capture. Generally, a toadlet was able to escape from an ant either by struggling or, if toadlets were able to return to the water the ant would release its grip and return to the dry areas of the shore. This aversion behaviour appeared to lead to a large number of toadlets remaining in the water perched on any floating object (e.g., water lilies, strips of bark) and a very low proportion of toadlets moving about on the moist substrate. This contrasts with the normal behaviour of recently metamorphosed toadlets that are heliophytic and during the day forage on the moist substrate around the margin of the water body (Freeland and Kerin 1991).

In order to make a preliminary assessment of the possible effect of ant presence on toad behaviour we observed the number of ants and toadlets found in eight  $2.5 \times 1$  m quadrats placed on the moist substrate of the pond margin. Quadrats were laid with the 1 m side parallel to and 50 cm from the pond edge to exclude toadlets in and immediately adjacent to the water. Counts were made inside these areas every two hours for a 24 h period from 1200 h on March 15. Over the same period

temperature and humidity were recorded and casual observations were made in areas up to 40 m from the pond edge to determine the extent of the area covered by foraging toadlets. The level of activity of toadlets (alert or immobile) was also noted during observation periods.

The highest numbers of toadlets were found in the quadrats early in the morning and in the late afternoon (Fig. 1). There were fewer toadlets on the moist substrate in the warmer part of the day (Fig. 2). Observations also indicated that the toadlets were generally found only within a short distance from the water's edge except for a brief period in the early morning (0600–0800 h) when toadlets were found up to 35 m from the pond returning to the water's edge *en masse* at around 0800 h. Toadlets were alert during daylight but all toads seen from 2000 and 0400 h were immobile and failed to respond when prodded.

By contrast, ants were found in the quadrats only from 0800 to 1800 h with peak numbers occurring between 1000 and 1400 h. Their active period corresponded with the return of the toadlets to the pond edge and ceased in the late afternoon, immediately prior to the afternoon peak in toadlet numbers.

The data must be interpreted cautiously because observations were made over only one 24 h period. However, the data suggest that it might be possible for the ants to alter the daytime behaviour of the toadlets. At a nearby pond (<1 km) where no ant predation was observed, similar sized toadlets were active up to 6 m from the water's edge at the same time

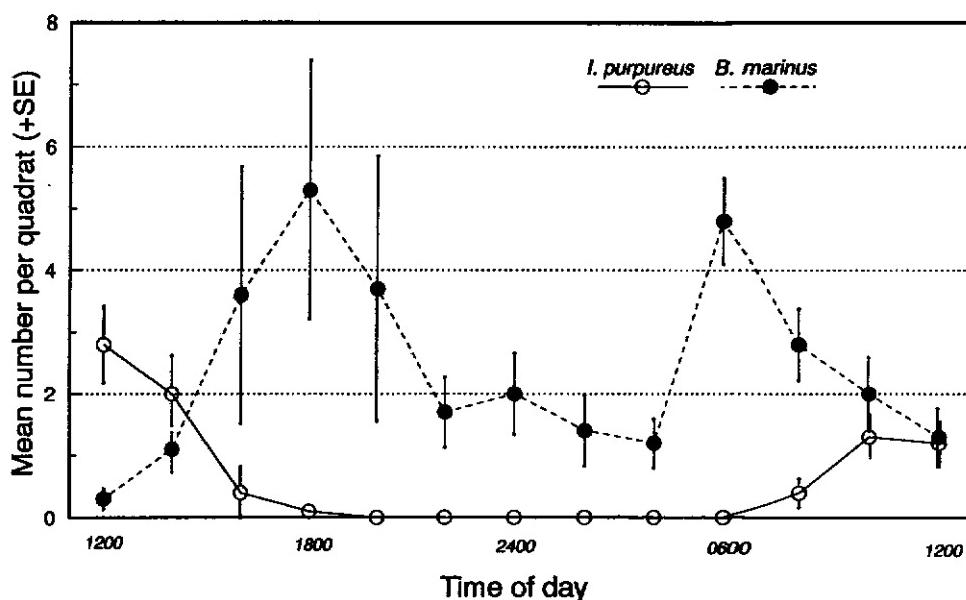


Figure 1. The mean number of ants (*Iridomyrmex purpureus*) (solid line) and toadlets (*Bufo marinus*) (dashed line) found in quadrats at 2 h intervals from 1200 h March 15 to 1200 h March 16, 1992.

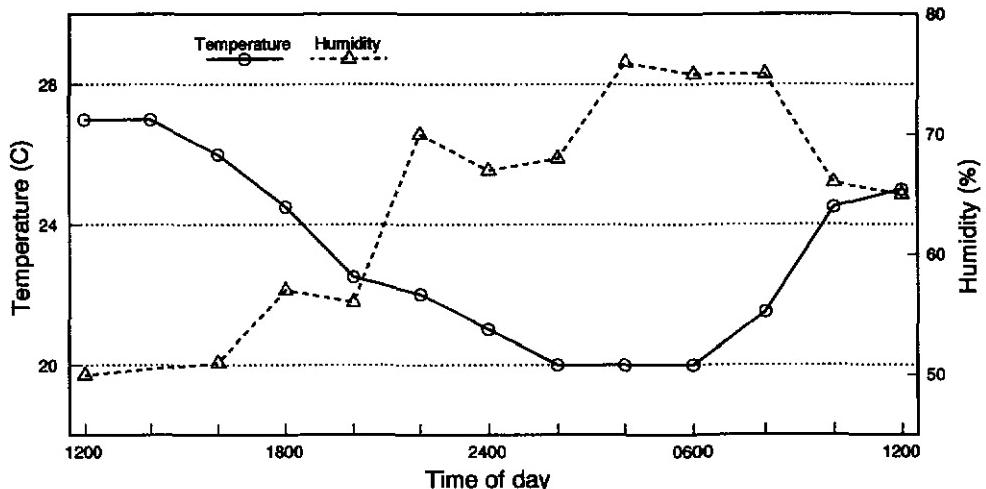


Figure 2. Temperature (solid line) and humidity (dashed line) recordings made at 2 h intervals for the 24 h period from 1200 hr on March 15, 1992.

(1000–1200 h) that toadlets at the pond with ant predation were confined to land within 0.5 m of the water and objects floating in the water.

Freeland and Kerin (1991) have found that the physical environment of the Gulf Country of the Northern Territory resulted in toadlets having a diurnal pattern of activity in moist habitats adjacent to water. Recently metamorphosed toadlets were found mostly within 5 m of the water's edge and showed peak activity between 0400 and 2000 h. The level of activity was influenced by physical factors such as humidity, moisture of substrate, wind conditions and temperature. Combinations of factors either producing conditions that restricted evaporative cooling during high daytime temperatures or were likely to lead to a lowering of body temperature at night tended to impede activity. Their findings suggest the prevailing climatic conditions during our observations (high temperature, total cloud cover and wind, plus a moist substrate) were optimal for toadlet daytime activity. In our study toadlets were active during daylight but were not utilizing all the available moist habitat during daylight periods.

The direct impact of ant predation on toad survival was not clear. Counts of the number of toadlets being processed in  $15 \times 5$  m sections of the pond margin (1100 h, March 8) gave a mean estimate of 0.6 toadlets/1 m ( $\pm 0.18$  SE) of pond shore examined. Given the pond was 270 m in circumference and assuming the ants were active for eight hours (Fig. 1) and each toadlet took at least 30 min. to be processed, then the ants could be removing up to only 2700 toadlets/day. The density of toadlets was estimated on the same day as being 270 000 ( $\pm 64000$  SE; based on  $52 \times 0.0625$  m $^2$

quadrats taken within a 3 m margin of the pond). These crude estimates suggest predation may have only a minor direct impact on toadlet density. However, the indirect effects of ant predation on toadlet survival may be more important if the ants are preventing the toadlets from foraging over all available areas of moist substrate.

Interactions between *I. purpureus* and recently metamorphosed toads deserve more attention. *Iridomyrmex purpureus* is a common ant species with a wide geographical distribution (Taylor and Brown, 1985) and it may play some role in influencing population sizes of the introduced toad.

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#### REFERENCES

- COVACEVICH, J. AND ARCHER, M. 1975. The distribution of the Cane Toad, *Bufo marinus*, in Australia and its effects on indigenous vertebrates. *Mem. Qld Mus.* 17(2): 305–10.
- FLIER, J., EDWARDS, M. W., DALY, J. W. AND MYERS, C. W., 1980. Widespread occurrence in frogs and toads of skin compounds interacting with the ouabain site of Na<sup>+</sup>, K<sup>+</sup>-ATPase. *Science* 208: 503–05.
- FREELAND, W. J., KERIN, S. H., 1991. Ontogenetic alteration of activity and habitat by *Bufo marinus*. *Wildl. Res.* 18: 431–43.
- HAMLEY, T. AND GEORGES, A., 1985. The Australian snapping tortoise *Elseya latisternum*: a successful predator of the introduced cane toad? *Aust. Zool.* 21: 607–10.
- LICHT, L. E., 1968. Unpalatability and toxicity of toad eggs. *Herpetologica* 24: 93–98.
- TAYLOR, R. W., BROWN, D. R., 1985. Formicoidea. Pp. 5–149 in *Zoological Catalogue of Australia*. Vol. 2. *Hymenoptera*. AGPS: Canberra.

- TYLER, M. J., 1987. Frog and cane toad skin secretions. Pp. 329–39 in *Toxic plants and animals: a guide for Australia* ed by J. Covacevich, P. Davie and J. Hearn. Queensland Museum: Brisbane.
- VAN BEURDEN, E., 1980. Report on the results of stage 3 of an ecological and physiological study of the Queensland cane toad *Bufo marinus*. Report to Australian National Parks and Wildlife Service, Canberra.
- WASSERSUG, R., 1971. On the comparative palatability of some dry-season tadpoles from Costa Rica. *Amer. Midl. Nat.* **86**: 101–09.
- ZUG, R. AND ZUG, P. B., 1979. The marine toad, *Bufo marinus*: a natural history résumé of native populations. *Smithsonian Contributions to Zoology* No. **284**.

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## New South Wales Field Ornithologists Club Lecture

Tuesday, March 2: *How do YOU keep your records?* — Introduced by Walter Boles.

At Hallstrom Theatre,  
Australian Museum at 8.00 p.m.

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## Founding patterns of *Exoneura bicolor* Smith in Cobboboonee State Forest, southwestern Victoria

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### ABSTRACT

The study investigated the effects of pyrrhic succession on sociality and some life-history parameters of a facultatively social Australian native bee, *Exoneura bicolor*. In a comparison between trap nests and established colonies, it was found that established colonies contained, on average, more females and more brood per colony. There was no difference in the number of females per trap nest between areas at different stages of pyrrhic succession, although there was some difference in the proportion of trap nests colonized. The greatest proportion of trap nests colonized were in sites where fire had passed a year prior to the trap nests been set. Electrophoretic assay of the females in co-founded nests showed that relatedness between co-founders is not significantly different from zero, although the sample size was small. It was established that emus *Dromaius novaehollandiae* were responsible for breaking the inaccessible inflorescences from the nesting substrate, thereby allowing the bees access to the nesting substrate. These data support the hypothesis that *E. bicolor* are able to take advantage of the abundance of nesting sites that follow fire.

### INTRODUCTION

Fire is an important feature of the Australian ecosystem, as is evidenced by the widespread adaptations of many Australian native plants to fire. To date there has been considerable research on the effects of burning on flora and vertebrate fauna, but comparatively little on terrestrial invertebrates. What has been done is mainly on fossorial invertebrates, both on leaf litter and the soil itself (Campbell and Tanton 1981; Suckling and Macfarlane 1983). Although invertebrates are sometimes inconspicuous, they form the largest proportion of faunal biomass and the effect of invertebrate herbivores and plant parasites on a habitat can be greater than that of vertebrate herbivores. Because of the importance of invertebrates in an ecosystem, it is necessary to understand the impact of fire on life-history and population parameters of these animals.

This study concentrates on the effects of fire on a plant pollinator, the native bee *Exoneura bicolor*, in Cobboboonee State Forest near Portland, Victoria. *E. bicolor* Smith is interesting because it is a plant pollinator in a fire-prone environment, and so must have experienced periodic fire for a long time. Additional data were also collected on the population densities of two other *Exoneura* species, *E. bicincta* Rayment and *E. (Brevineura) rufitarsis* Rayment.

*E. bicolor* is a common bee which nests in pithy stems throughout southeastern Australia and is found from montane open forest to heathland. Its nests consist of unlined, unbranched burrows that are not divided into cells (Schwarz 1986). Immatures are placed in the nest lumen, not confined to cells, and are provisioned progressively throughout their development by females within the colony (Schwarz 1987). In the Portland region the